Cost-efficient broccoli head phenotyping using aerial imagery and SfM-based weakly supervised learning

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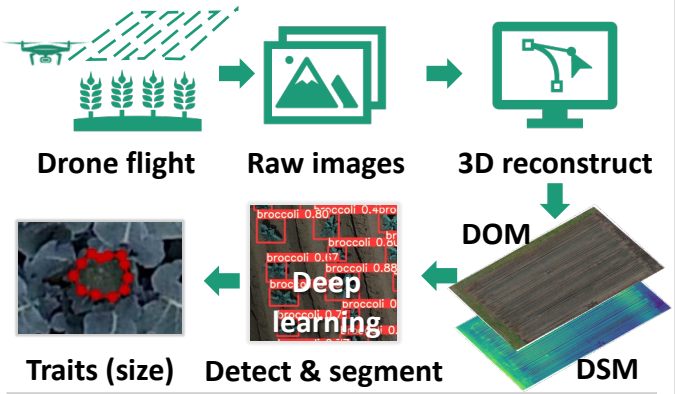
Background

Aerial imagery phenotyping



High throughput & labor-saving

Challenges

Low efficiency in data annotation

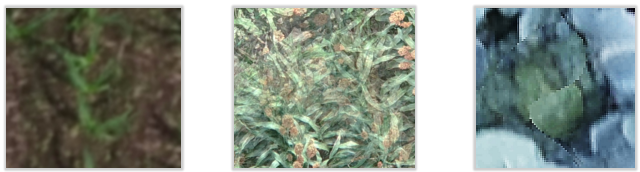
Huge number of training data need to be labeled manually (2000+)

High computation cost

Training and applying model is time-costly for common deep learning models

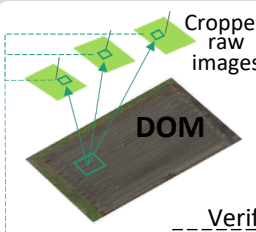
Low accuracy in traits from DOM

The traits accuracy suffers from low DOM quality



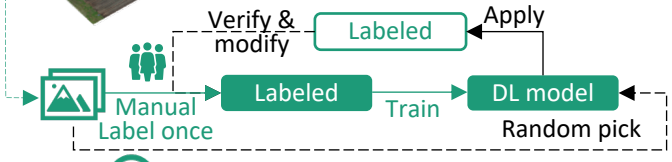
Low resolution | Double mapping | seamline distortion

Solutions



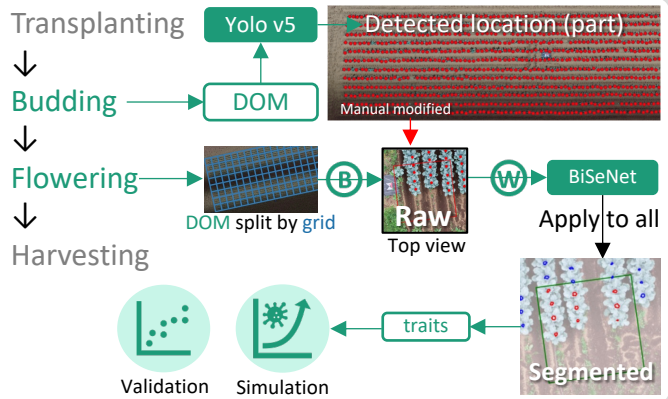
Backward projection

Find correspond position in the raw aerial images



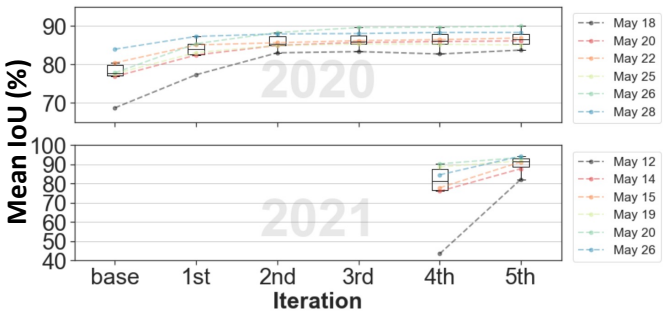
Weakly supervised learning

Workflow



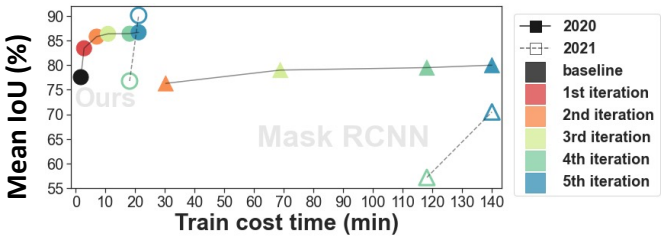
Results

Detecting accuracy



Achieve acceptable and migratable model after a few iterations of labor-saving label adjustment (1 hour per iter.)

Compare to Mask R-CNN



Our method is faster and more accurate

Measured Traits (part in mm)

label	area	convex_area	eccentricity	major_axis_length	minor_axis_length	perimeter	circularity
1	6059	6647	0.615269	100.735769	79.411777	326.776695	0.713031
2	8860	9663	0.211285	108.662199	106.209088	401.374675	0.691104
3	5777	6408	0.415282	91.251193	83.010534	322.326948	0.698745

Future work

1. Validate with field measurement
2. Simulate advanced traits (e.g. weight)
3. Predict the best harvest time considering the current market price